

What is claimed is:

1, A driving apparatus comprising:

a base;

multiple displacement members, the base ends of which are fixed to the base and the tip ends of which are combined at one location, said displacement members generating a prescribed displacement;

a pressure unit that keeps the synthesizing member, at which the tip ends of the displacement members are combined, in pressure contact with the driven member, which comprises the object of driving;

a driving circuit that impresses drive signals to the displacement members;

a controller that controls the driving circuit so that the synthesizing member moves in an elliptical path and the drive force is transmitted to the driven member; and

a first detector that detects the amplitudes of the displacement members and the phase difference therebetween,

wherein based on the results of detection by the detectors, the amplitudes or phases of the voltages impressed to the displacement members are changed to adjust the elliptical locus of the synthesizing member.

2, A driving apparatus according to claim 1,

wherein the controller changes the phases of the impressed voltages to adjust the flatness of the elliptical locus.

3, A driving apparatus according to claim 1,

wherein the controller changes the amplitudes and phases of the impressed voltages to adjust the direction of the elliptical locus.

4, A driving apparatus according to claim 1,

wherein the controller changes the amplitudes and phases of the impressed voltages

to adjust the drive force transmitted to the driven member.

5, A driving apparatus according to claim 1,

wherein the phases of the impressed voltages when the driven member begins to move are different from such phases at other times.

6, A driving apparatus according to claim 5,

wherein the phases is changed such that the driving characteristics include low speed and high torque when the driven member begins to move, while including high speed and low torque otherwise.

7, A driving apparatus according to claim 1, further comprising a memory means that stores the target amplitudes and target phase differences that correspond to the target elliptical locus of the synthesizing member,

wherein the controller changes at least either the amplitudes or phases of the impressed voltages so that the difference between the amplitudes detected by the first detector and the target amplitudes stored in the memory means and the difference between the phase difference detected by the first detector and the target phase difference stored in the memory means are eliminated.

8, A driving apparatus according to claim 7,

wherein the memory means stores multiple target amplitudes and phase differences that correspond to the target elliptical locus of the synthesizing member in such a manner that they are associated with a timing at which the parameters of the elliptical movement should be changed.

9, A driving apparatus according to claim 8,

wherein the elliptical movement when the driven member begins to move is different from such movement at other times.

10, A driving apparatus according to claim 9,

wherein the elliptical movement is changed such that the driving characteristics include low speed and high torque when the driven member begins to move, while including high speed and low torque otherwise.

11, A driving apparatus according to claim 7,

wherein the controller drives only one of the multiple displacement members.

12, A driving apparatus according to claim 7,

wherein the multiple displacement members include multi-layer piezoelectric elements, and the first detecting means detects the amplitude and phase of the voltage impressed to each displacement member based on the electric current that is drawn to the multi-layer piezoelectric element.

13, A driving apparatus according to claim 1, further comprising a second phase difference detecting means that detects the phase difference between the voltage impressed to each displacement member and the electric current drawn thereto,

wherein the controller changes the drive frequency of each displacement member based on the phase difference detected by the second phase difference detecting means.

14, A driving apparatus according to claim 13, further comprising a memory means that stores the target amplitudes and target phase differences that correspond to the target elliptical locus of the synthesizing member,

wherein after adjusting the driving frequencies to become the resonance frequencies based on the phase difference detected by the second phase difference detecting means, the controller changes either the amplitudes or phase of the impressed voltage such that the difference between the amplitudes and phase difference detected by the first detector and the target amplitudes and phase difference stored in the memory means, respectively, are eliminated.

15, A driving apparatus according to claim 14,

wherein the memory means stores multiple target amplitudes and phase differences that correspond to the target elliptical locus of the synthesizing member in such a manner that they are associated with a timing at which the parameters of the elliptical movement should be changed.

16, A driving apparatus according to claim 15,

wherein the elliptical movement when the driven member begins to move is different from such movement at other times.

17, A driving apparatus according to claim 16,

wherein the elliptical movement is changed such that the driving characteristics include low speed and high torque when the driven member begins to move, while including high speed and low torque otherwise.